Developing a Questionnaire to Assess Noise Exposure in Children and Teens

A Senior Honors Thesis

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by

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Abstract

Until recently, children and teenagers were not thought to be an at-risk population for noise induced hearing loss (NIHL). As MP3 players have grown in popularity, there has been an increased awareness of possible noise exposure and hearing loss in children and teens. NIHL is a cumulative hearing loss that is due to repeated exposure to noise. Concerns about NIHL in children and teens are raised due to the opportunities for noise exposure that they may encounter in their daily environments. Children and teens can be exposed to potentially dangerous levels of noise during activities at school, part-time work, recreational activities, and even household chores (e.g. musical instruments, lawn mowers, dirt bikes, and vacuums).

The need to identify, diagnose, and treat hearing loss, as close to the onset is crucial, especially for children. Hearing loss in children and teens impacts their speech perception, learning, self-image, and social skills. NIHL is virtually 100 percent preventable; therefore identifying any risk of NIHL as early as possible can stop its progression and severity.

The present study attempts to develop a questionnaire to help identify children and teens at highest risk for NIHL. Mandated hearing screenings in schools provide an opportunity to reach those at risk. A noise exposure questionnaire may be a useful companion tool for the hearing screenings. Research about questionnaire development was completed to determine what survey format would be most effective. Items on the questionnaire were selected based on research regarding current concerns of NIHL and sources of noise exposure in children and teens. Five experts in the field of hearing conservation reviewed the questionnaire to address face validity. Comments provided by the experts were taken into consideration and the questionnaire was revised. In the future, a field trial of the questionnaire should be completed in order to correlate the results of the questionnaire to behavioral audiometric test results.

Introduction and Literature Review

Noise-induced hearing loss (NIHL) occurs when an individual is continually exposed to hazardous sound levels. Continuous exposure to noise damages the structure of the inner ear, resulting in hearing loss. Hazardous sound levels are defined by two parameters: the time (duration) and level (intensity) of exposure. Agencies such as the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA) have established regulations for maximum allowable noise exposure. The regulations are generally described as the duration per day (hours) one can be exposed to a sound level (dBA) before damage may occur. For example, regulations set by OSHA state that exposure to a 110 dBA sound level for longer than half of an hour may result in damage. Noise-induced hearing loss can be temporary or permanent, depending upon these two parameters of sound levels, duration and intensity. The symptoms of NIHL will increase with louder and longer exposure time (Rabinowitz, 2000). Symptoms often include difficulty understanding speech at a conversation level and a ringing sound in the ears known as tinnitus. It is important to note that there is individual variation in noise exposure and its subsequent consequences.

According to The National Institute on Deafness and Other Communication Disorders (2006), more than 30 million Americans are regularly exposed to hazardous sound levels and about 10 million Americans can attribute their hearing loss, in some way, to noise. Excessive noise can be found in workplaces, recreational settings, and even at home. Sources of noise include firearms, power tools, motorcycles, and vacuums.

Early detection and intervention are the keys to managing hearing loss (Gracey, 2003). The need to identify, diagnose, and treat hearing loss, as close to the onset is crucial, especially for children (ODH, 2001). Hearing loss in children and teenagers impacts their speech

perception, learning, self-image, and social skills. Isolation, frustration, and depression may also result as a consequence of hearing loss (Folmer, Greist, and Martin, 2002). Even with just a slight hearing loss, children and teens may be missing listening information and thus, are at risk for learning problems (Niskar et al, 1998). NIHL is virtually 100 percent preventable through avoiding noise exposure when possible and wearing hearing protection when it is not. Identifying any risk of NIHL as early as possible will stop its progression and severity. When considering the irreversible damage of NIHL along with the ability to prevent the condition, NIHL should be a public health issue.

Since NIHL occurs over time, children and teens were often not thought to be an at-risk population for the condition. This is because NIHL is a cumulative result of exposure to noise and thus, should correlate to age. Recent research has suggested the contrary. Today's environment is noisier than ever and it appears that the prevalence of NIHL among children may be increasing. The first large, national study done by Niskar, Kieszak, Holmes, Esteban, Rubin, and Brody (2001) estimated the prevalence of noise-induced threshold shifts (NITS) among children in the United States. With NITS, high-frequency sounds such as whistles and buzzers may be muffled and speech consonants may be more difficult to discriminate. If NITS influences a person's communication and behavioral skills, his or her education, social interactions, employment, and quality of life may be adversely affected. NITS can progress with continued noise exposure to include other frequencies and to increase in severity. Permanent NITS is irreversible. The study found that 12.5% of US children (approximately 5.2 million), ages 6 to 19 years old, have noise-induced threshold shifts in one or both ears. This suggests that children are being exposed to hazardous levels of noise. Concerns about NIHL in children and teens are raised due to the opportunities for noise exposure that children and teens encounter in

their daily environments (Holmes et al, 1997). Common noise encountered by children and teens include musical concerts, fireworks, lawnmowers, stereos, and toys.

Recently, the media has given attention to the issue of noise exposure in children and teens due to the popularity of devices such as iPods and other MP3 players. In 2006, the Cable News Network (CNN) reported a poll conducted for The American Speech-Language-Hearing Association (ASHA). The poll found that 59% of students played music at a high volume on their MP3 players (this is dependent on the listener's perception of loudness) and 51% had experienced at least one of the symptoms of hearing loss. The CNN article also discusses how earbud-style headphones that are sold with many music players may be more damaging to the ear than traditional headphones. Traditional headphones cover the entire external ear which blocks more background noise than earbud-style headphones, allowing users to play their music at a lower volume. The poll found that only 23% of students have purchased a different pair of headphones for their players.

As mentioned earlier, the damage that these devices may do to a person's hearing depends on how long and at what level the music is played. Listening to a high intensity sound for a short period of time may not result in permanent hearing loss, but chronic exposure that accumulates over time may cause hearing loss. A cumulative exposure of noise may cause a slight hearing loss in childhood to become a moderate to severe hearing loss in adulthood (Chung, 2005). Apple, the company that manufactures iPod, does allow listeners to set a maximum volume output. The maximum volume output sets a limit on the intensity at which the music is played (Apple website, http://www.apple.com/sound/). But if no limit is set, iPods can reach up to 115 dB. Exposure to 115 dB for any duration may potentially damage one's hearing.

The media has covered other sources of noise exposure as well. An excerpt from a book titled *Save Your Hearing Now* was covered on Good Morning America's website. The excerpt gives comparisons of sounds that are similar in intensity, many of which are startling. For example, comparisons were made between the intensities of car stereo systems and a jet during takeoff, movie soundtracks and power saws, and children's toys and air-raid sirens. Children and teens in their everyday life may encounter these harmful sounds.

Children and teens may also be exposed to noise in part-time work or household chores. A study by Broste, Strand, and Stueland (1989) studied the prevalence of hearing loss among teen-aged farm children. The results indicated three main findings. The first finding is an increased prevalence of hearing loss among high school students who engage in farm work, as compared to their peers who do not. Children on the farm spend a great deal of time around noisy machinery such as tractors and combines. The current Occupational Safety and Health Administration (OSHA) standards for permissible noise exposure are 90 dBA for 8 hours or less and 95 dBA for 4 hours or less. This study found that only 1 of 31 tractors produced less than 85 dB and that 6 of 31 tractors produced more than 95 dB. The second finding is that only 9% of the students wore hearing protection when working on the farm. Use of hearing protection reduces the amount of noise exposure on the farm. Those who did wear hearing protection had a lower prevalence of hearing loss, showing that preventative efforts are successful. The last finding is that hearing loss observed in adult farmers may begin in childhood. This is an example of how NIHL is a cumulative effect of noise exposure, as described above.

Another common source of noise exposure are recreational activities. A study done by Dalton, Cruickshanks, Wiley, B. Klein, R. Klein, and Tweed (2001) investigated the association between leisure-time noise exposure and hearing loss. A noise exposure questionnaire was

administered as an interview to obtain participants' exposure to leisure-time noise. The participants were questioned about participation in ten noisy leisure-time activities: carpentry or woodworking; metalworking; driving a motorcycle or noisy recreational vehicle such as an all-terrain vehicle (ATV), race car, motor boat, or snowmobile; doing yard work with power tools; using a chain saw; playing a musical instrument; using noisy kitchen appliances such as a blender, mixer, or food processor; using a vacuum cleaner; using a handheld or salon-type hair dryer. Further details were asked such as how often and for how long each activity was performed, how loudly he or she would have to speak to be heard within 2 feet of another person, how often hearing protection was worn, and if tinnitus occurred afterwards. The conclusion of the study found that participants who engaged in leisure activities where the average sound level was 90 dB or greater were significantly more likely to have a hearing loss than those who did not. Woodworking was found to be the most damaging activity, with those who had done woodwork 31% more likely to have a hearing loss. This study was applied to the adult population but may provide a model for children and teens. Children and teens may have similar types of noise exposure as adults. A majority of the noisy recreational activities adults participate in, children and teens may participate in also.

Chung, Des Roches, Meunier, and Eavey (2005) also did a study of noise exposure involving survey techniques, but focused it on younger people (35 and younger). The objectives of the study were to evaluate awareness of NIHL among young adults, examine perceptions of hearing protection, and identify factors that might influence behavior in a positive way. Researchers at the Massachusetts Eye and Ear Infirmary, the Harvard School of Public Health, and Cogent Research, Inc created the survey. The survey had 28 questions, formatted with multiple choice and open-ended questions. It was administered as a pop-up survey to every 30th

visitor to the MTV.com web site. The results of the survey found many important statistics. Only 8% of respondents defined hearing loss as "a very big problem" compared to other health issues such as sexually transmitted diseases at 50%, alcohol/drug use at 47%, and depression at 44%. These results show that hearing loss is a very low priority health issue among adolescents and young adults. This may be because hearing loss is a cumulative effect and may not be considered to have an immediate impact on their life. The consequences of hearing loss may be considered far in the future. A second statistic found that 43% of respondents had experienced tinnitus or temporary hearing loss while attending clubs, concerts, etc. and only 14% reported use of hearing protection. Obviously, the use of hearing protection will be low in correlation with the low priority of hearing loss stated above. Perhaps the most important finding of the survey was that 66% of respondents would be inclined to wear hearing protection after being made aware of the potential for permanent hearing loss. But only 9% of respondents had ever received education at school relating to hearing health. There is an opportunity to change young people's hearing behaviors, such as wearing hearing protection, through awareness and education as shown by these statistics.

There are numerous general public health programs available to raise awareness and educate children and teens about hearing conservation. Public awareness may reverse the increasing trend of NIHL seen in this population. In 2002, Folmer, Griest, and Martin reviewed existing hearing conservation education programs for children. They gathered information on 29 different organizations that produce and distribute hearing conservation curricula. Some of the organizations reviewed included *Crank It Down!* available from the National Hearing Conservation Association, *Dangerous Decibels* developed by the Oregon Hearing Research Center, and *Wise Ears* provided by the National Institute on Deafness and Other Communication

Disorders. The information was gathered to be a useful resource for educators and school administrators. The paper gives a list of the programs and reviews each one's components. Overall, Folmer, Griest, and Martin found the programs to be effective but the problem is the lack of distribution of this important information to children.

Due to the importance of early detection of potential NIHL and intervention, the present study attempts to develop a questionnaire to help identify children and teens at highest risk for NIHL. Current guidelines set by the Ohio Department of Health require hearing screenings at kindergarten, 1st, 3rd, 5th, and 9th grade (ODH, 2001). ODH states that hearing screenings are an efficient and effective health assessment procedure. These mandated hearing screenings provide an opportunity to reach those at risk. A questionnaire assessing noise exposure may be a useful companion tool for the hearing screenings. Research about questionnaire development was completed to determine what survey designs would be most effective for the target population and for the information to be collected. Items on the questionnaire were selected based on research regarding current concerns of NIHL and sources of noise exposure in children and teens. Five nationally recognized experts in the field of hearing conservation reviewed the questionnaire to address face validity. Face validity is concerned with whether the questionnaire appears to measure what it is supposed to measure. Some of the questions asked when determining face validity are, "Is this a reasonable way of obtaining the desired information?" "Is it well designed?" and "Might it work reliably?"

Surveys are a quick way to obtain information. However, one problem of surveys is determining whether people are able to recall and report past behaviors accurately. A cross-sectional study by Ahmed, Dennis, and Ballal (2004) aimed to determine the accuracy of self-reported high noise exposure level and hearing loss in a working population of Eastern Saudi

Arabia. The study involved 259 noise-exposed workers from two factories. Each worker's personal noise exposure was determined using a noise dosimeter. Pure-tone air conduction audiometry was also done to determine hearing thresholds. The workers completed a comprehensive questionnaire including questions about noise exposure and hearing loss. Eighty-five percent of workers reported exposure to high noise level. The noise dosimeter found that 76% were actually exposed to high noise level (greater than 85 dBA). This report is fairly accurate (estimate was within 9.6%) in identifying workers exposed to high noise level. However, it overestimated the prevalence rate of hearing loss determined by the audiometry. The conclusion of the study was that questions addressing noise exposure and hearing loss might be a useful alternative means for screening subjects when objective assessments are not available.

Numerous questionnaires assessing noise exposure and hearing loss in occupational workers (generally adults) are easily found. Many workplaces use surveys as a tool to monitor their workers' hearing health. Since children and teens were not thought to be a population at risk for NIHL until recently, there are not many questionnaires designed to assess their noise exposure. Those that are available are general hearing screening questionnaires that ask just a few questions about noise exposure, hearing protection, etc. The present study attempts to develop a questionnaire that can be specifically used to assess noise exposure in children and teens.

Methods

A questionnaire was developed to assess noise exposure in children and teens. The goal of the questionnaire is to quickly and accurately identify those at highest risk for NIHL. The idea for the development of a questionnaire assessing NIHL in children and teens came about from recent media attention on noise exposure and research suggesting an increased prevalence of NIHL in this population. The idea also came about because a current AuD graduate student is working on her capstone project in which she is looking at the 6000 Hz frequency to determine if it should be included in routine hearing screenings. A threshold shift at the 3000, 4000, or 6000 Hz frequency on an audiogram is often an indicator of NIHL. A threshold shift at these frequencies commonly follows exposure to hazardous noise. It was thought that a questionnaire assessing noise exposure may further support identifying those at risk for NIHL.

The first step in the development of the questionnaire was to research current concerns regarding NIHL and sources of noise exposure in children and teens. This information was used to determine what topics should be included on the questionnaire. The three main topics that were decided to be included on the questionnaire are the symptoms of NIHL, possible sources of noise exposure, and use of hearing protection.

The second step in the development of the questionnaire was to research how to construct an appropriate and effective survey. One of the principal reference is this area is Dillman's text (2000) *Mail and Internet Surveys* . Outlined in this text are aspects of writing questions, specifically the wording and structure of questions. Some of the principals for constructing survey questions that were chosen for the questionnaire include using simple wording and keeping the questions short. These principals were especially important in looking at the target audience of children and teens, and the necessity to select vocabulary appropriate for these ages.

In addition, construction of the questionnaire focused on formatting that could be easily followed and did not seem too overwhelming.

The third step in the development of the questionnaire was to create a first draft of the questionnaire. The information that was collected during the research process was used to do this. The research about questionnaire development determined what survey formats would be most effective for this population and for the information to be collected. Items on the questionnaire were selected based on the research regarding current concerns about NIHL and sources of noise exposure in children and teens.

The fourth step in the development of the questionnaire was to distribute the first draft of the questionnaire to 5 nationally recognized experts in the field of hearing conservation. The experts chosen are colleagues of the project advisor. The draft was sent via e-mail. The experts reviewed the questionnaire for face validity and made suggestions for improvement. The questionnaire was then revised based on these suggestions.

Results

Description of the Questionnaire Content: (see Appendix A)

Question 1:

Question 1 addresses one of the symptoms of NIHL, difficulty understanding speech, especially in background noise (NIDCD, 2006). For students, difficulty hearing the teacher in class may assess whether this symptom is present. This question is also important because children's academic success may be at risk if they are missing auditory information in the classroom.

Question 2:

Question 2 addresses a second symptom of NIHL, tinnitus or the sensation of ringing in the ears (NIDCD, 2006). Exposure to hazardous sound levels is often accompanied with tinnitus. It may be assumed that children who have experienced tinnitus have been exposed to dangerous sounds and may be at risk for NIHL.

Question 3:

Question 3 addresses a specific source of noise exposure, portable media players. These devices have become increasingly popular among children and teens and may become the most encountered source of noise exposure for this population. The second part of question 3 addresses how long respondents listen to their device per session. This information is important because the damage these devices may do to a person's hearing depends on how long the music is played (Rabinowitz, 2000).

Question 4:

Question 4 addresses the intensity at which respondents listen to music or the television. The volume respondents set their media players or televisions at may indicate two things: the presence of an existing hearing loss and if the intensity of the sound is at a dangerous level.

Question 5:

Question 5 addresses various leisure-time activities that may be potential sources of noise exposure (Niskar et al, 2001 and Holmes et al, 1997). Participation in one or more of these activities on a regular basis may result in NIHL.

Question 6:

Question 6 addresses the use of hearing protection. The use of hearing protection is an important factor in the prevention of NIHL. Children and teens that are exposed to noise and do not wear hearing protection may be considered at highest risk for NIHL.

Description of the Questionnaire Format:

- The goal of the questionnaire is to quickly and accurately identify children and teens at highest risk for NIHL. If the questionnaire is to be used as a companion tool during routine hearing screenings, it needs to be able to be administered in a short amount of time. This is why the number of questions was limited to six. The hope is that these six questions will be sufficient enough to accurately identify those at risk.
- Basic information will be collected at the top of the questionnaire: name, date, grade, and gender.
- The title of the questionnaire is Assessment of Noise Exposure in Children and Teens.

- General instructions are given and are placed before the first question. The instructions inform the respondents of the purpose of the questionnaire and ask that they answer all of the questions carefully.
- Questions are presented in the first person. This structure was thought to be the most appropriate for the target population (as young as 10 years old).
- Yes/No answers are required for the questions because they were thought to be the simplest responses. Additional space is given in order for respondents to provide more detailed information, which may lead to a more accurate assessment. Therefore, questions are both closed and open-ended.
- For question 5, a check-all-that-apply format was avoided to reduce a primacy effect. A primacy effect results when respondents just check the first few boxes, believe that sufficient information has been provided, and ignore the remainder of the choices. By having to answer for each activity, respondents must read the entire question.

Revised Questionnaire: (see Appendix B)

The questionnaire was revised according to the comments given by the five experts in the field of hearing conservation. Changes were made to improve the validity of the questionnaire.

- Questions 1 & 2 were moved to the end of the questionnaire in order to avoid any influence they may have had on the remainder of the questions. They are now Questions 6 & 7.
- Questions 1, 2, & 6 were changed from yes/no answer choices to vague quantifiers. Vague quantifiers are a set of ordered categories that help respondents make judgments

about how often or how much they do something. Measurement scales for these questions may provide more detail than a simple yes or no response.

- The open-ended portions of Questions 1 & 2 were reworded in order to better explain the instructions.
- Question 3 was split into two separate questions so that respondents would not mistakenly skip the second half of the question.
- Question 4 was omitted because it does not properly assess noise exposure. Answers to this question are dependent upon the environment (i.e. quiet or noisy) in which the respondent is listening.
- Revisions were made to the activities in Question 5. Video games and shooting fireworks were omitted and auto shop and use of farm/lawn equipment were added. These may be more common sources of noise exposure based on the input from the expert reviewers.
- The open-ended portion of Question 6 was omitted after making the question more specific ("… whenever I am around a loud sound).
- A question was added that requires respondents to mark on a visual analog scale the level at which they typically set the volume of their portable media players. Obtaining a gross estimate of the level of exposure is important in assessing risk of NIHL.
- A second question was added to determine if respondents have received education regarding hearing conservation.

Conclusion

Revisions of the questionnaire based on the experts peer review improved the questionnaire's overall face validity. The questions are now more technically accurate and may provide more detailed information about respondents' risk for NIHL. In the future, a field trial of the questionnaire should be completed in order to correlate the results of the questionnaire to behavioral audiometric test results. This will verify the questionnaire's actual content validity and reliability.

Due to the preventable nature of NIHL, early identification of NIHL and hearing conservation education for children and teens are necessary. The hope is that the questionnaire will eventually be implemented into routine hearing screenings in schools. The questionnaire may be a useful companion tool for these screenings to help identify children and teens at highest risk for NIHL.

Name: _____ Date: _____

Grade: _____ Gender: (Circle One) M F

ASSESSMENT OF NOISE EXPOSURE IN CHILDREN AND TEENS

The following questions focus on exposure to hazardous sounds. Please answer all of the questions carefully and to the best of your ability. Please be as specific as you can.

1. I have trouble hearing my teacher in class.

   □ Yes □ No

   - If yes, please explain when _____

     _____.

2. I experience ringing in my ears.

   □ Yes □ No

   - If yes, when? _____

     _____.

3. I own a portable media player such as an iPod or other MP3 player, a walkman or discman, or a portable DVD player.

   □ Yes □ No

   - If yes, on average I listen to it _____ minutes or hours (circle one) per session.

4. Others have told me that they could hear the music coming from my headphones or that I am listening to the T.V. too loudly.

   □ Yes □ No

5. I participate in the following activities on a regular basis.

Play an Instrument	□ Participate	□ Do not participate
Hunting	□ Participate	□ Do not participate
Woodshop	□ Participate	□ Do not participate
Dirtbikes/4-Wheelers	□ Participate	□ Do not participate
Attend Concerts	□ Participate	□ Do not participate
Video games	□ Participate	□ Do not participate
Shooting Fireworks	□ Participate	□ Do not participate

6. I use hearing protection such as earplugs or muffs.

   □ Yes □ No

   - If yes, when? _____.

Name: _____ Date: _____ Grade: _____ Gender: (Circle One) M F

ASSESMENT OF NOISE EXPOSURE IN CHILDREN AND TEENS

The following questions focus on exposure to hazardous sounds. Please answer all of the questions carefully and to the best of your ability. Please be as specific as you can.

1. **I own a portable media player such as an iPod or other MP3 player, a Walkman or Discman, or a portable DVD player.**

   - Yes (Go to Question 2)
   - No (Go to Question 4)

2. **On average I listen to it _____ minutes or hours (circle one) per session.**

3. **Draw a line on the scale below where you usually set the volume.**

   I——————————————————————————I
   MIN MAX

4. **I frequently participate in the following noisy activities:**

Play an Instrument	• Yes	• No
Hunt with Firearms	• Yes	• No
Auto/Wood Shop	• Yes	• No
Ride Dirtbikes/4-Wheelers	• Yes	• No
Attend Music Concerts	• Yes	• No
Use Farm/Lawn Equipment	• Yes	• No

5. **I use hearing protection such as earplugs or muffs whenever I am around a loud sound.**

   - Never
   - Rarely
   - Sometimes
   - Often
   - Always

6. **I have trouble hearing my teacher in class.**

   - Never
   - Rarely
   - Sometimes
   - Often
   - Always

   Please describe in what situation(s) you have problems hearing your teacher: _____

   _____

7. **I experience ringing or other noises in my ears.**

   - Never
   - Rarely
   - Sometimes
   - Often
   - Always

   Please describe when and how it occurs: _____

8. **I have been taught about the effects of hazardous sound on hearing in school.**

   - Yes
   - No

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